

Social Interactions and Student Achievement in a Developing Country:

An Instrumental Variables Approach

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The World Bank
South Asia Region
Human Development Unit
February 2008



Abstract

This paper identifies endogenous social effects in mathematics test performance for eighth graders in rural Bangladesh using information on arsenic contamination of water wells at home as an instrument. In other words, the identification relies on variation in test scores

among peers owing to exogenous exposure to arsenic contaminated water wells at home. The results suggest that the peer effect is significant, and school selection plays little role in biasing peer effects estimates.

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Social interactions and student achievement in a developing country: An instrumental variables approach

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The authors would like to thank Michelle Riboud for her valuable comments. The authors would also like to thank Sayed Rashed Al-Zayed Josh for his assistance with data processing. Note that this study does not represent the views of the World Bank or the Governments they represent.

1. Introduction

A well-known challenge in studies on the influence of peers in children's outcomes is that of identification of social effects. According to Manski (1993), peer effect can be explained by two distinct hypotheses. The hypothesis of "endogenous social effect" states that individual behavior is motivated by the average behavior of others in a reference group. Second is the hypothesis of "contextual effect": an individual's behavior in the group varies with the exogenous characteristics of the reference population. In addition to the conventional problem of omitted variable related bias, identification of an endogenous social effect is complicated by the "reflection problem": mean behavior of peers is also affected by the individual's own behavior.

Although there exists a sizable empirical literature on social interactions in school participation and attainment decisions, research exploring peer effects on student achievement, particularly using developing country data, is limited¹. Extant studies employ a variety of techniques to resolve the identification problems such as experimental design (e.g. Bobonis and Finan, 2007), school fixed-effects (Arcidiacono and Nicholson, 2005; Ammermueller and Pischke, 2006) and instrumental variable approach. Two recent studies have attempted to resolve the issue of identification within an instrumental variable framework. Cipollone and Rosolia (2007) use data on earthquake shocks in Italy and the subsequent relief from military training of males to identify social effects on school completion of Italian females². On the other hand, Lalive and Cattaneo (2006) identify the peer effect on school attendance decision for a sample of children in Mexico who were ineligible for a randomly targeted school grant program. Identification is established using variation in mean schooling of peers due to exposure to the school grant by a fraction of the peers. In both studies, existence of an exogenous shock affecting the schooling outcome of a sub-sample of peers has been central for the purpose of identification. We note that in rural Bangladesh, a significant part of the population has been exposed to arsenicosis -- intake of arsenic-contaminated drinking water at home -- which has serious health and learning implications³. Continuous drinking from arsenic-laced wells is highly cancerous and causes

¹ See Soetevent (2006) for an extensive review.

² Boys high school graduation rate is instrumented with the exemption from compulsory military service.

³ The extent of the crisis is nation-- according to Rohde (2005), as many as 20 million Bangladeshis have been drinking groundwater water contaminated with naturally occurring inorganic Arsenic for nearly over two decades (see Geen, Ahmed and Madajewicz (2005) for a detailed account of the crisis).

various other health disorders including birth complications. Arsenicosis is also found to be negatively associated with learning outcomes in rural Bangladesh (Asadullah and Chaudhury, 2007a⁴; Wasserman et al., 2004) and elsewhere (ASTDR, 2005). In this paper, therefore, we use information on arsenicosis among peers to construct an instrument for the mean test score of peers and adopt an instrumental variable approach to estimate the peer effect modelled as an endogenous social effect⁵.

2. Methodology

We adopt a simple OLS regression model for test scores with controls for various demand and supply side factors where individual schooling achievement varies linearly with mean achievement in the group and with other personal and family attributes that may be common across all group members. Such simple linear-in-means regression with group (school) average variables can be specified as follows:

$$S_{bi} = \beta E_b [S_{bi}] + \delta x_{bi} + \alpha_b + \varepsilon_{bi} \quad (1)$$

where, S_{bi} is test score and $E_b[S_{bi}]$ is the corresponding group level (i.e. mean test score of children in b-th school) analogue; x_{bi} proxies for individual specific characteristics (e.g. gender, religion, parental education etc.) of i-th child in b-th school⁶. α_b is unobserved heterogeneity common across children within the b-th school and ε_{bi} is a random error term. We assume away any contextual social effect.

δ in equation (1) is a measure of endogenous social effect. Given that x_{bi} are pre-determined, contextual effects are exogenous in educational production. Poor control of α_b - the “correlated effect” -- may lead to bias in the estimated endogenous and contextual effects. However, even if no correlated effects are present in the data, β is not identified in a simple linear regression (unless additional assumptions are made), due to what Manski calls “reflection problem”. Data on outcomes do not reveal whether group behavior actually affects individual behavior or group behavior is simply an aggregation of individual behavior. So, the endogenous effect can not be separated from other contextual effects. To identify β ,

⁴ Looking at test score by arsenic pollution status of tube well at home, children from affected households have systematically lower maths score. Most importantly, Asadullah and Chaudhury find that these differences in raw data prevail even when they account for various conventional determinants of school performance and subjective well being such as socio-economic condition of the family, personal attributes, schooling history and school attributes (including arsenic contamination status of tube wells at secondary school).

⁵ We do not consider contextual effects. It is not uncommon to exclusively focus on endogenous effect. For example, see Evans et al. (1992).

⁶ In the calculation of school averages we take out the index child.

the endogenous social effect parameter, we need data on an exogenous shock which affect schooling of some but not all school peers. To this end, we use data on “fraction of peers exposed to arsenic contaminated water-wells at home” as an instrument for $E_b[S_{bi}]$ and follow an the instrumental variable approach to estimate equation (1) to resolve the identification problem.

3. Data and survey description

The data used in this paper has been collected in 2005 as part of a larger study to assess school quality in rural Bangladesh. The primary sampling unit of the survey was chosen to be unions⁷. To account for regional variation in school participation rate and so on, 60 unions were selected with proportional allocation from 6 divisions in the country. In the second step, all secondary (recognized secular and religious) schools in each of the sample unions were selected for data collection. In total, 321 schools could be identified in the 60 unions (or school catchment areas). A mathematics test was administered to all students in enrolled in grade 8 in our sample schools, who were present on the day of the survey⁸. Each student taking the test was asked to answer a number of questions relating to their family background and pre-secondary school history. To identify arsenic-exposure, we asked sample pupils whether there was a tube-well at home and if so, whether they were arsenic contaminated⁹. 13% of sample kids belong to households with arsenic contaminated tube wells (see Asadullah and Chaudhury (2007a) for a descriptive discussion of the sample by arsenic exposure).

4. Results

Table 1 reports the regression estimates of the endogenous social effect. Certain parts of rural Bangladesh have remained less unexposed to ground water poisoning of arsenic leading to spatial variation in arsenicosis. Therefore, the regressions always condition on a large number of region dummies. We start with a parsimonious model, regressing individual test score on mean test score of peers (model 1). Correcting for endogeneity of peer variable returns a slightly smaller albeit significant estimate of social effect (model 2). Next, we

⁷ Union is an administrative unit bigger than a village but smaller than thana/upazila.

⁸ The test instrument was constructed by adopting 20 items previously used in the Trends in International Mathematics and Science Study (TIMSS), 1999; see Asadullah et al. (2007b) for details.

⁹ By the year 2004, the Government of Bangladesh had completed a nationwide screening of tube wells in rural areas. Following this exercise, wells identified as contaminated were painted *red* whilst those ascertained as being safe were painted *green* (BAMWSP, 2005). Therefore, contamination status was ascertained by asking kids whether tube well at home was painted *red* or *green*.

exploit the richness of the data and control for various individual, household and school level (past as well as contemporaneous) correlates of learning (model 3). For this specification, instrumental variable estimate of peer effect returns a coefficient of 0.70 (model 4). The size of the coefficient is slightly reduced to 0.65 when we additionally treat school type (whether an Islamic school) as endogenous (model 5) (for details, see Asadullah et al., 2007b). In all cases, however, our estimate of endogenous social effect remains statistically significant.

Table 1: OLS and 2SLS estimates of peer effects, full sample

| | (1) | (2) | | (3) | (4) | | (5) | |
|---|--------------------|------------------|--------------------|--------------------|------------------|--------------------|------------------|--------------------|
| | OLS | 2SLS | 1st stage | OLS | 2SLS | 1st stage | 2SLS | 1st stage |
| Mean maths score of peers | 0.960 (87.01)** | 0.713 (2.25)* | | 0.957 (82.33)** | 0.700 (2.26)* | | 0.657 (2.10)* | |
| Fraction of peers with arsenic-affected homes tubewells | | | -0.037 (3.35)** | | | -0.041 (3.47)** | | -0.040 (3.44)** |
| N | 7710 | 7710 | 7710 | 7710 | 6595 | 6595 | 6595 | 6595 |
| Control for family and school attributes ? | No | No | No | Yes | Yes | Yes | Yes | Yes |
| Regional FEs? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| F-test stat | | 11.23 | | | 12.05 | | 11.85 | |
| Overid | | --- | | | --- | | 0.21 | |
| R-squared | 0.48 | 0.43 | 0.02 | 0.50 | 0.45 | 0.08 | 0.44 | 0.08 |

Note: Absolute value of t statistics in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%. Each regression additionally contains dummies indicating tube well non-availability in school and at home, whether tube well at school is arsenic-contaminated and a set of 5 dummies indicating which day of the week the test was taken. All specifications control for regional FE. Specification (5) additionally instruments the school type (whether an Islamic school).

Lastly, a potential concern of our identification strategy is that the incidence of arsenicosis may be localized – even within the same administrative region (i.e. union), some cluster of households could be more affected by arsenic contamination. If so, this would lead to violation of the exclusion restriction. To this end, we estimate the educational production function restricting our sample to children who are not affected by arsenicosis¹⁰. And because assignment to arsenic-contaminated water well is random, we use the resultant exogenous variation in student achievement to identify peer effects on the test score of

¹⁰ This stratification strategy is similar to Bobonis and Finan (2007) who use the exogenous variation in school participation (caused by a randomly placed program, namely the Progres program) to identify peer effects on the school enrolment of ineligible children residing in the same communities.

unaffected children residing in the same communities. We find that peers have considerable influence on the enrollment decision of children from arsenic-free households.

Table 2: OLS and 2SLS estimates of peer effects, sample of arsenic-free children

| | (1) | (2) | | (3) | |
|---|--------------------|------------------|--------------------|-----------------|--------------------|
| | OLS | 2SLS | 1st stage | 2SLS | 1st stage |
| Mean maths score of peers | 0.960 (78.65)** | 0.680 (1.87)+ | | 0.604 (1.62) | |
| Fraction of peers with arsenic-affected homes tubewells | | | -0.047 (2.94)** | | -0.044 (2.79)** |
| N | 6785 | 5671 | 5671 | 5671 | 5671 |
| Control for family and school attributes? | Yes | Yes | Yes | Yes | Yes |
| Regional FEs? | Yes | Yes | Yes | Yes | Yes |
| F-test | | 8.66 | | 7.80 | |
| Overid | | --- | | 0.13 | |
| R-squared | 0.51 | 0.45 | 0.07 | 0.43 | 0.07 |

Notes: Sample as Table 1.

To conclude, the evidence of endogenous social effect has important implications for policy. An endogenous effect is characterized by a multiplier effect: government interventions to boost the learning of one child raises the schooling of other children in the reference population which in turn further boosts the schooling of the targeted child, therefore resulting in large social multiplier effects.

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